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X-RAY STUDY OF ALPHA-BETA TRANSFORMATION IN KERATIN*

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(*Received November* 12, 1957)

ABSTRACT. A measure for the degree of order introduced in alpha-beta transformation in keratin fibres is defined and its determination is carried out in three varieties of human hair. It is concluded that the behaviour of golden hair is much nearer to the black than to the white.

INTRODUCTION

The X-ray study of alpha-beta transformation in keratin was made first by Herzog and Jancke (1921) and Astbury and Street (1932) Since then it has always occupied a pivotal position in all attempts to arrive at the molecular structure determination of proteins. Configurations for the polypeptide chains have been proposed by Astbury and Bell (1941), Huggins (1943) and by Bragg, Kendrew and Perutz (1950) The most satisfactory model has been the one proposed by Pauling, Corey and Branson (1951). In their model the protein chain is considered as coiled into a 3 7 residue helix of pitch 5.4 A.U. and a repeat distance of 1.5 A.U. parallel to the axis. The successive turns of the spiral are held together by a hydrogen bond between a CO group and a nitrogen atom and it crumples up very much like certain type of fabrics which contain elastic threads Recently, Bendit (1957) has reported in case of Lincoln wool the variation of peak intensities of the 4 6 A.U , 5 1 A U. and 9 8 A U reflections against percentage extension. He concluded that Astbury's hypothesis of a molecular transformation based on a 1 : 1 correspondence of the intensity variation of the first two reflections is not tenable Pauling's model has also been supported by the researches of Cochran and Crick (1952). However, so far no quantitative X-ray study of the degree of order introduced with extension has been reported

The outstanding reflections in the alpha photograph of human hair are the meridional strong arc of spacing 5.1 A.U made up of (020) flanked on either side by (120) and the composite equatorial reflections (001), (101), (300) and (201) This is spread over three A.U. and has a mean spacing of 9.8 A.U. The (100) reflection because of its closeness to the centre does not lend itself to an easy evaluation and is, therefore, omitted During the course of transformation from alpha to beta which sets in *at* about 30% extension, the meridional arc begins to close up.

*Communicated By Prof. K. Banerjee. D.Sc., F.N.I.

However, it never completely disappears. In addition to this there appears on the equator a new spot of 4.6 A.U. and the over-all definition of the photograph also improves. If we denote the intensity of the meridional and equatorial reflections by I_m and I_e respectively, the degree of order Ω may be defined by the relation

$$\Omega = \frac{I_e - I_m}{I_e + I_m} \times 100$$

This expression has the advantage of being independent of all exposure factors.

EXPERIMENTAL

In order to carry out an experimental determination of this degree for the three different varieties of human hair, X-ray photographs of suitable intensity were taken of bundles of fibres well combed to ensure parallelism (CuK_α radiation from a Seifert's sealed tube working at 40 K.V. and 20 m.A and monochromatised

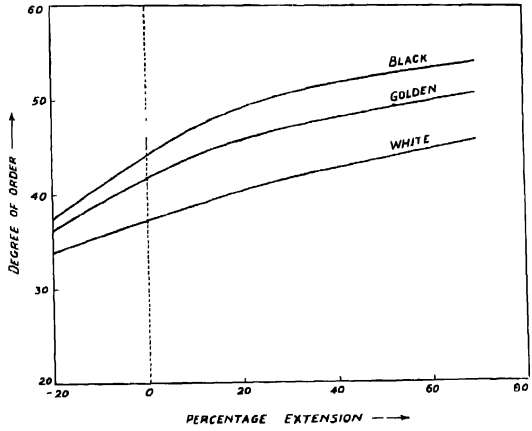

Fig. 1

by reflection from a calcite crystal was used with specimen to film distance of 5 cm. The fibres were held taut between two pin-vices, one of which was movable and carried a screw gauge to measure extension. The fibres were always stretched in water at room temperature and super-contracted by stretching first in steam and later on allowing them to recover in steam itself. Intensity measurements were made by Moll's recording type microphotometer. In a few cases the intensity measurements were also checked by rotating the film. Under these conditions a spot was uniformly spread out over an annular area and two scannings were given at right angles to each other. The average value of these intensities was

multiplied by the factor obtained on dividing the annular area by the area traversed by the exploring beam in one scanning. It was found that the intensity measurements in the two cases were within experimental error and agreed fairly well. All measurements were reduced to the same scale. The results obtained are tabulated below

Variety	Supercontracted	Unstretched	Stretched			Treated with cupra-ammonium hydroxide
			40%	60%	70%	
Black	38.13	43.97	51.9	53.19	54.09	0
Golden	37.58	41 80	48.01	50.12	51.12	0
White	34.21	37 03	43.82	45.83	46.60	0

DISCUSSIONS

The above results which have also been graphically represented show that the change is exponential. Initially there is a relatively rapid rise in the degree of order but later on the change not very large when the extension varies from 60% to 70%. Further, the behaviour of golden hair is nearer to that of the black than that of the white The difference may be ascribed to the change in pigment, presence of air bubbles in white hair and other changes produced during the course of metabolism. On treatment with cupra-ammonium hydroxide it was found that the fibre photograph completely disappeared because of the contraction having arisen from an extra folding of the chains induced by co-ordination of the absorbed copper with appropriate groups in the keratin chains A study of this "reversible supercontraction" produced on washing with dilute H_2SO_4 is also being made and a detailed account of the work would be shortly published elsewhere.

ACKNOWLEDGMENTS

The author is grateful to Professor K Banerjee, D Sc., F.N I , for his valuable guidance and encouragement throughout the progress of the work

REFERENCES

Astbury, W T. and Street, A. 1932. *Phil Trans. Roy. Soc* , *A*, 230, 75.
Astbury, W T. and Bell, F. O. 1941, *Nature* (*London*), 147, 696
Huggins, M. L 1943, *Chem. Rev.*, 32, 195
Bragg, L., Kendrew, J. C. and Perutz, M. F. 1950, *Proc Roy. Soc.*, 203*A*, 321
Pauling, Linus; Corey, Robert B and Branson, H. R. 1951. *Proc. Nat. Acad Sciences* (*Washington*), 37, 205.
Bendit, E. G. 1957, *Nature* (*London*), 179, 535
Cochran, W and Crick, 1952, *Nature* (*London*), 169, 234.